2 Sheets--Sheet 1.

W. S. DEEDS.

Air-Compressors.

No. 152,468. Patented June 30, 1874.

FIG. 2

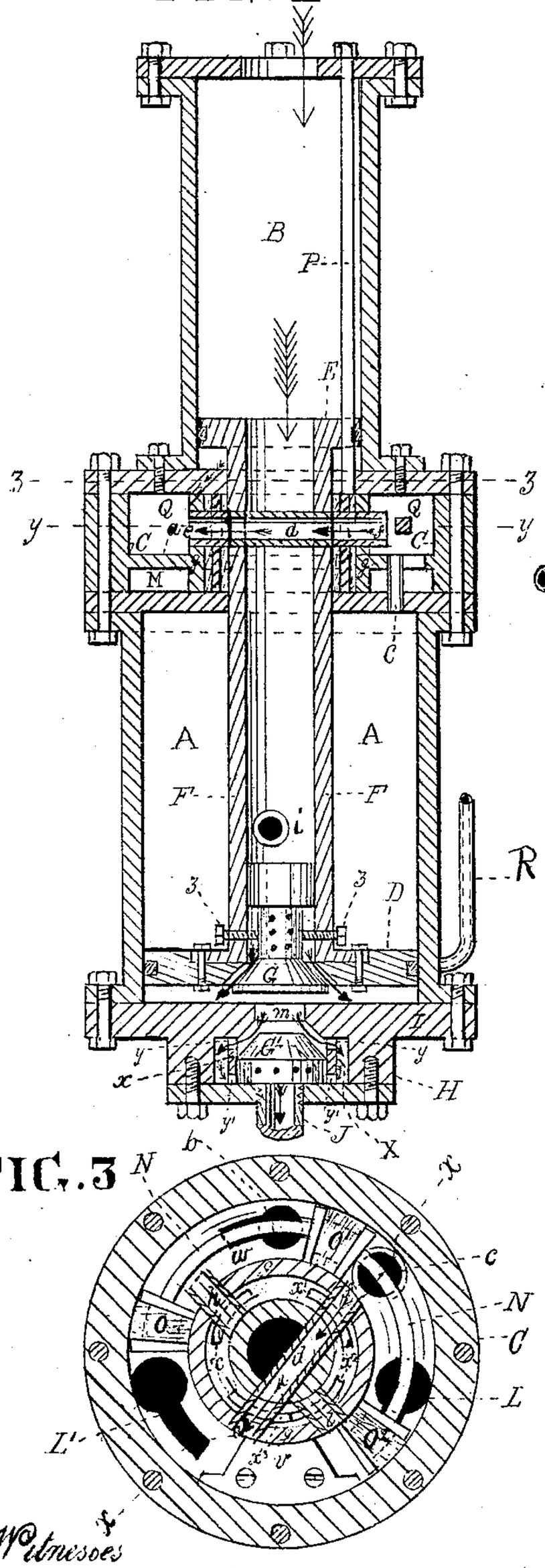

FIG. 3

FIG. 1

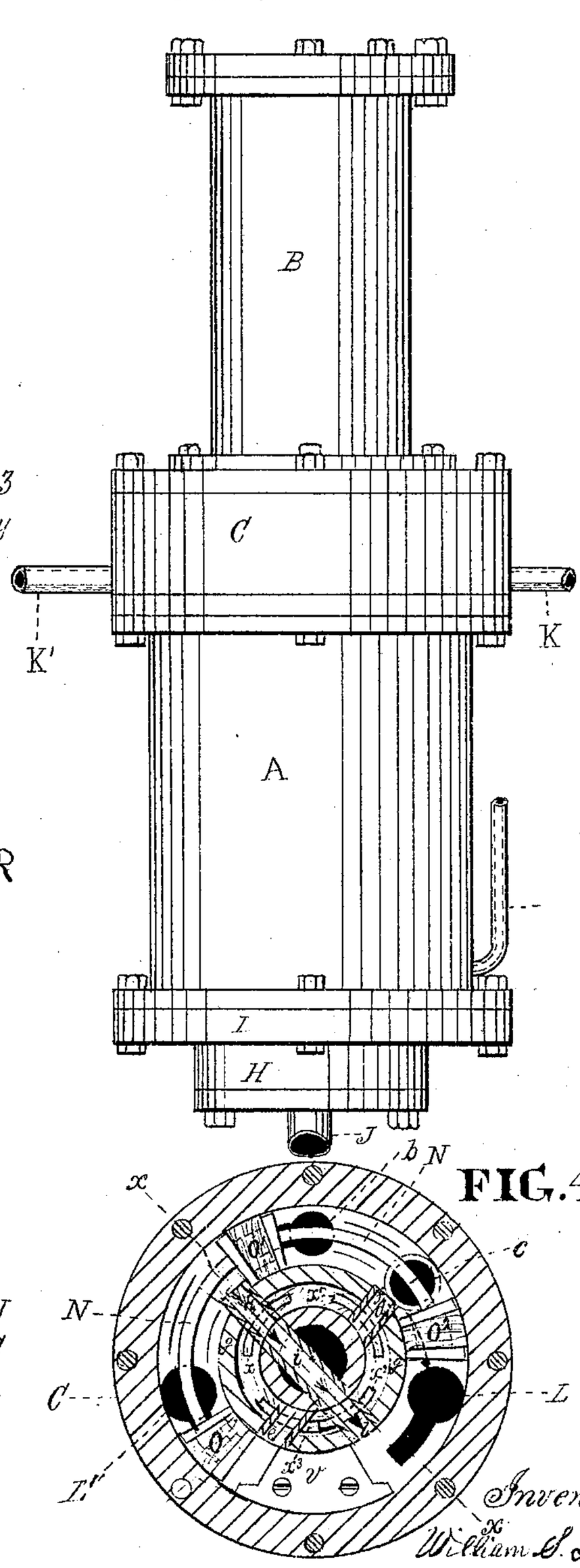

FIG. 4

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2 Sheets--Sheet 2.

W. S. DEEDS.

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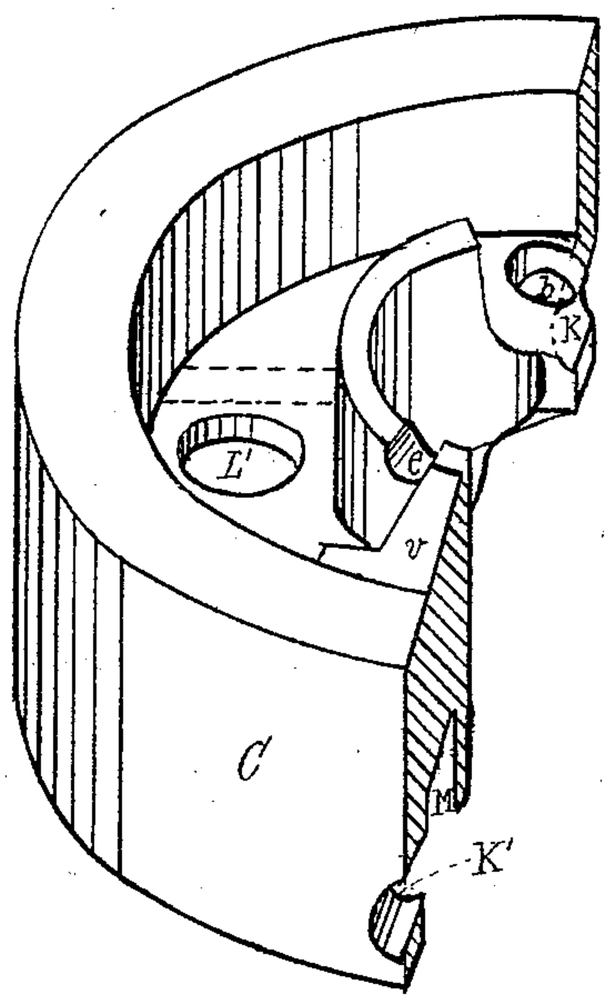
No. 152,468. Patented June 30, 1874.

FIG. 5



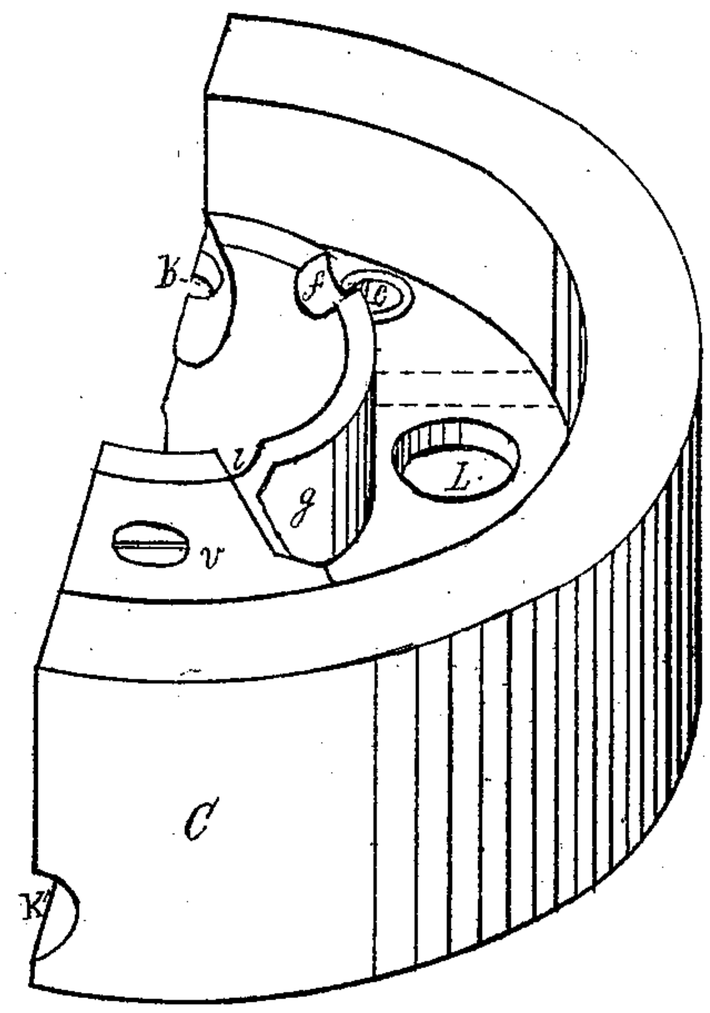


FIG. 7

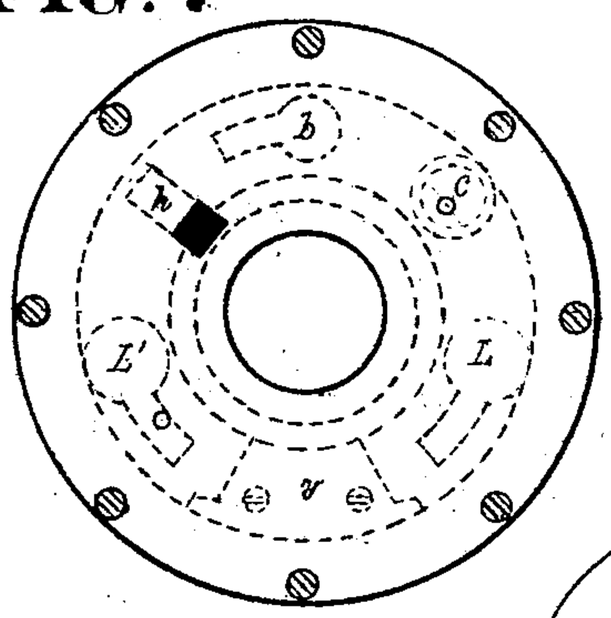


FIG. 8

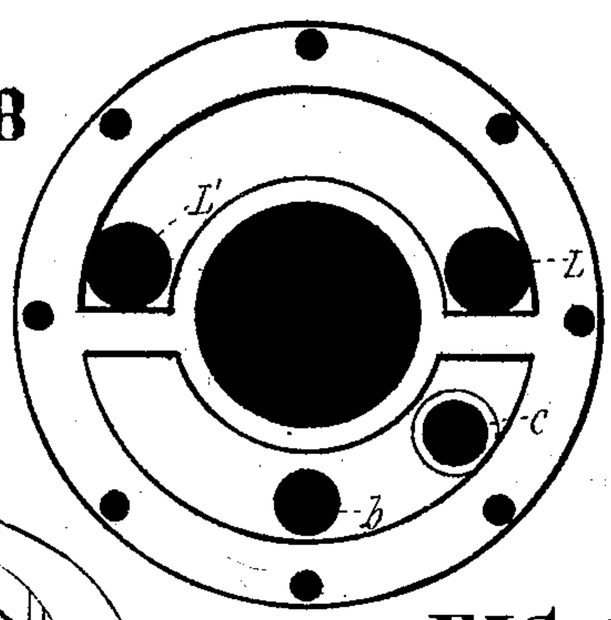


FIG. 6

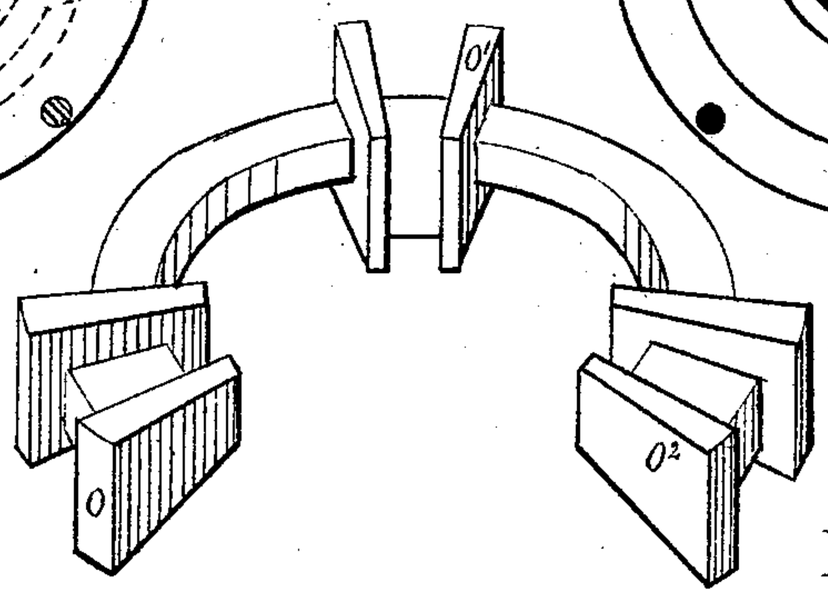
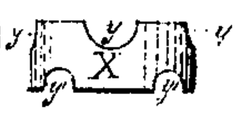


FIG. 9

FIG. 10



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IMPROVEMENT IN AIR-COMPRESSORS.

Specification forming part of Letters Patent No. **152,468**, dated June 30, 1874; application filed September 30, 1873.

To all whom it may concern:

Be it known that I, WILLIAM S. DEEDS, of the city of Philadelphia and State of Pennsylvania, have invented a Direct-Acting Steam Air-Compressing Engine, for heating railroad-cars, buildings, &c., of which the following is a specification:

My invention relates to a novel cut-off device, by means of which the engine is made direct-acting, and in combination therewith of two steam and air cylinders, of different diameters, centrally arranged with each other, and having their pistons connected together by means of a hollow piston-rod, which has near each end a small tube passing through it for the passage of steam to the cut-off valves, to change their positions for the reversed strokes of the pistons, and so arranged as to cause the steam on one side of the larger piston to force it downward or forward, and force air out of the cylinder on the other side of the piston through a valve, which is opened by the pressure of the air into a reservoir. Both pistons are carried back in their reversed stroke by the action of steam on the lower side of the smaller piston. At the same time the large cylinder is charged with atmospheric air, that enters the outer and open end of the small cylinder, and passes down through the hollow piston-rod, and opens a valve at the lower end of the same, which connects with the large piston, and through which the air flows into the large cylinder during the upward stroke of the piston. One object of using the air in the same cylinder in which steam is applied is the cooling of the cylinder by the air. Another object is the economizing of the heat imparted by the steam to the cylinder; and also to give simplicity and cheapness to the construction, and the arrangement of all the moving parts inside of the engine, and thus insure protection thereto, as well as to take up as little room as possible.

The main purpose of this invention is to use it in connection with my car-heater, the application for Letters Patent of which was filed May 16, 1873.

Figure 1 is a side elevation of the cylinders A and B, having in connection the cylindrical steam-chest C. Fig. 2 is a vertical section of the same, taken at line *x x* of Fig. 3. Fig. 3 is a cross-section at line *y y* of Fig. 2. Fig. 4 is a cross-section, taken at the same line *y y*, cutting through the tube *i* in the lower end of the piston-rod F, when the pistons are in their upward position. Fig. 5, Sheet No. 2, is a perspective view of the steam-chest C, on an enlarged scale, separated in the middle for the purpose of exhibiting the interior. Fig. 6 is a perspective view of the cut-off valves O, O^1, and O^2. Fig. 7 is a horizontal section, taken at the line *z z* of Fig. 1. Fig. 8 is a reversed plan view of the steam chest C. Figs. 9 and 10 are an end and a side view of the annular guide X.

Like letters of reference in all the figures indicate the same parts.

A is the large steam and air cylinder, and B a small steam-cylinder, connected therewith by means of the annular steam-chest C, which is fastened between the contiguous ends of the cylinders by the screw-bolts. The use of the small cylinder B and piston E is merely the carrying of the large piston D back to its upward position, and consequently the cylinder is only made large enough to form a space around the connecting-rod F of sufficient area to receive the requisite pressure of steam on the lower side of the piston E, to carry the piston up, and exhaust the steam from the cylinder A. The piston D of the steam-cylinder A, and the piston E of the cylinder B, are connected with the ends of the hollow piston-rod F, the bore of the rod serving for the passage of air from the cylinder B to the lower side of the piston D, to be compressed and forced into a reservoir for heating purposes, the bore at the lower end of the rod being opened and closed by means of the valve G, as seen in Fig. 2. The downward movement of the valve is governed by means of the pins Z Z, which pass through opposite sides of the piston-rod F, the head of the rod of the valve resting thereon. G′ is a valve in the case H, on the lower side of head I of the cylinder A, through which the air is forced through the pipe J into a reservoir, not shown in the drawings. X is an annular guide for the valve, having openings *y* at its top edge, for the passage of air into the annular space *z*, and open-

ings y^1 at its bottom edge for the passage of the air from thence through the openings y^2 to the interior of the valve, whence it passes down through the pipe J into the reservoir. K represents a portion of the steam-pipe which leads from the steam-chest C to the boiler; and K′ the exhaust-pipe.

In the partition-plate *a* of the steam-chest C, *b* represents the port which lets live steam from the chamber *w*, in the lower side of the steam-chest C, into the annular chamber Q, in the upper side of the steam-chest; and *c*, a pipe which leads from the annular steam-chamber Q, down through the chamber *w*, into the cylinder A. L is a port which exhausts steam from the cylinder A, when in communication with the charge-pipe *c*, as seen in Fig. 4. When the valves O, O^1, and O^2, are in the position they assume in this figure, the communication is cut off between the live-steam port *b* and said pipe *c* by means of the valve O^1, whereby the steam in the cylinder A exhausts back through the pipe *c*, and is discharged into the chamber M through the port L. L′ is a port which exhausts steam from the cylinder B, when the valves are in the position seen in Fig. 3, and in this position the valve O^1 cuts off the communication between the live-steam port *b* and the charge-port *h* of the steam-cylinder B, and the valve O opens the communication of the same with that of the exhaust-port L′, whereby the steam exhausts back through the port *h*, and into the exhaust-chamber M through the port L′. The exhaust-ports L and L′ have extensions, as shown in Figs. 3 and 4, to allow the air between the partition *v* and the cut-off valves O and O^2 to exhaust while the valves are being pushed toward the partition. The inlet-port *b* has an extension toward the charge-port *h*, so that it the cut-off valve O^1 should stop over the port it will not completely close off the steam, and the port being much the largest toward the charge-port *c*, the piston D will be operated by the steam when the valve O^1 stops midway over the port *b*, and its extension; and when it stops over the port *b*, the extension admits steam to operate the piston D. R is a small tube or pipe in the lower end of the cylinder A. It leads to an expansion-valve (not seen in the drawing) in the steam-pipe to close the valve and cut off the steam from the lower end of the cylinder A by means of the pressure of the air in the cylinder at a given portion of the stroke of the piston D, the expansion-valve being provided with a spring or weight, which is arranged to resist a given amount of pressure, and which opens the valve when the piston D is moving back, the pressure of the air being withdrawn.

The operation is as follows: When the pistons D and E are in their lower positions, represented in Fig. 2, the small tube *d* across the hollow piston-rod F, at its upper end, communicates with the ports *e* and *f* in the sides of the stuffing-box *g*, whereby the steam passes from the space between the valves O^1 and O^2, seen in Figs. 3 and 4, through the tube *d* and the ports *f* and *e*, and operates on the valve O, and pushes around the three valves O, O^1, and O^2, in the position seen in Fig. 3, cutting off the port *b*, which admits live steam, from the port *c* of the steam-cylinder A, and at the same time opens the communication between the port *c* and the exhaust-port L, whereby the steam is exhausted from the cylinder A, back through the pipe *c*, and into the exhaust-chamber M, through the port L, during the upward stroke of the pistons D and E, which is caused by the steam operating on the lower side of the piston E of the small cylinder B, by means of the communication of the port *b* of the live steam with the port *h*, (seen in Figs. 2 and 7,) between the valves O and O^1, as shown in Figs. 3 and 7. When the pistons assume their upward position, the small cross-tube *i* in the lower end of the hollow piston-rod F communicates with the ports *k* and *l*, (seen in Figs. 3, 4, and 5,) and steam passes from the space between the valves O and O^1, through the port *k*, the small tube *i*, and the port *l*, and operates on the valve O^2 to turn the valves around to the opposite side of the steam-chest C, into the positions seen in Fig. 4, whereby the live-steam port *b* is put into communication with the port *c*, to admit live steam into the cylinder A to operate the piston D, causing it to descend into its lower position, (shown in Fig. 2,) while, at the same time, the exhaust-port L′ is brought into communication with the port *h* between the valves O and O^1 to exhaust steam from the cylinder B during the downward stroke of the piston D. The cylinder B being open at its upper end, atmospheric pressure is exerted on the piston E, and the area of the upper side of said piston being greater than that of the under side, the atmospheric pressure on the lower side, while the steam is exhausting, is more than balanced.

The air to be compressed is admitted to the large cylinder A through the hollow piston-rod F, provided with a valve, G, at its lower end, the pressure of the air on the upper side of the valve opening and retaining it in its open position during the upward stroke of the pistons, whereby the air is admitted to rush into and fill the vacuum in the lower end of the cylinder, caused by the ascent of the piston. The air is forced out of the cylinder A during the downward stroke of the piston D, through the port *m* and valve G′ at the lower end of the cylinder A, and through the vertical pipe J, into a reservoir, (not seen in the drawings,) the valve G being closed by the pressure of air on its lower side during the downward stroke of the piston. The lower valve G′ is closed during the upward motion of the pistons by the back pressure of air in the reservoir (mentioned in the preceding sentence) upon the lower side of the valve. The atmosphere is admitted to the engine through an opening in the upper end of the small cylinder B. The opening should be con-

nected by means of a pipe with an air-filterer; or it may be provided with a sieve, to prevent the passage of anything that might be mixed up with the air, that would clog the engine. The pistons are prevented turning around and misplacing the openings of the tubes *d* and *i* by a rod, P, situated at one side of the interior of the cylinder B, and passing through the piston E. The exhaust steam from both cylinders, A and B, discharges through the ports L and L′ into the exhaust-chamber M, (seen in Figs. 1, 5, and 8,) and passes from thence through the pipe K′ into a coil of steam-pipe into the reservoir, (not seen in the drawings,) or wherever desired. The live steam from a steam-boiler charges the steam-chamber *w* (seen in Figs. 5 and 7) by means of a pipe, K, communicating with the port *y*. The partition *v* in the steam-chest is for an abutment of the steam in the cut-off valves O, O^1, and O^2. Small plates *x*, *x*^{1}, *x*^{2}, and *x*^{3} are placed between the shell of the stuffing-box *g* and the rod F to cover the ends of the tubes *d* and *i* and keep the stuffing in the stuffing-box from closing upon them. They have ports in them to admit of the passage of steam to the ports *e* and *l* from the ports *k* and *f*. The box *g* answers both for a stuffing-box and for a partition to form an annular space for the cut-off valves O, O^1, and O^2 to operate in. The steam exhausts back from the cylinders through the same ports through which it is charged. The valves O, O^1, and O^2 are provided with stuffing to make them steam-tight, and for this end they are provided with a groove, *u*, as seen in Fig. 6.

By attaching the engine to a steam-boiler and connecting with it an air-vessel or reservoir and an automatic regulator, to regulate the running of the engine, the latter may be used for heating buildings, drying lumber, &c. By operation with steam at sixty pounds pressure and upward the air will be made hot enough by compression for general heating purposes. But the exhaust steam from the engine may also be employed to assist in heating the air when the engine is operated by steam at a lower pressure.

I claim as my invention—

1. The combination and arrangement of the cylindrical steam-chest C with a steam and air cylinder, A, hollow piston-rod F, and a steam cylinder, B, substantially in the manner and for the purpose herein specified.

2. The combination and arrangement of the cylindrical steam-chest C, cut-off valves O, O^1, and O^2, charge port or pipe *c*, charge-port *h*, exhaust and steam ports K and K′, and the stuffing-box *g* with the hollow piston-rod F, and steam and air cylinders A and B, substantially in the manner and for the purpose described.

3. The combination and arrangement of the hollow piston-rod F, containing the small tubes *d* and *i*, with the stuffing-box *g*, steam-chest C, cut-off valves O O^1 and O^2, and the steam and air cylinders A and B, substantially in the manner and for the purpose set forth.

4. The combination of the hollow piston-rod F, having the small tubes *d* and *i*, with the pistons D and E, substantially in the manner and for the purpose herein shown.

5. The combination of the annular guide X, having openings *y* and *y*′, with the valve G′, and case H, substantially in the manner and for the purpose specified.

6. The combination of the pipe R with the cylinder A, substantially as and for the purpose set forth.

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